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## PATENT SPECIFICATION

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## (54) AXIAL FLOW GAS CLEANING DEVICE

(71) WE, FACET ENTERPRISES, INC., a corporation organized and existing under the laws of the state of Delaware, States of America, of 7030 South Yale, Tulsa, Oklahoma 74136, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a device for separating contaminants from a relatively high velocity axially flowing stream of gas such as may be required for internal combustion engines, diesel engines, jet aircraft engines, turbines or the like, and which require a clean supply of air or other gas.

Centrifugal force has been employed to separate solid contaminant particles from an axially flowing stream of gas and prior art devices have required that the centrifugal force be relatively high to accomplish the desired purposes and the resulting abrasive affect of the contaminants has tended to reduce the life of the device.

The main object of this invention is to provide a device for separating solid contaminant particles from a relatively high velocity axially flowing stream of gas.

Another object of this invention is to provide a device for separating the contaminant particles by inducing a tangential as well as a radial velocity vector to the axial inlet velocity of the particles whereby said contaminants are discharged through a discharge passage.

Another object of this invention is to accomplish the afternoted particle separation with a high efficiency and a low pressure drop in the axially flowing gas.

Another object of this invention is to accomplish the above by optimizing the geometrical relationship between the components of the device.

The present invention consists in a device for separating solid contaminants from a relatively high velocity axially flowing

stream of gas comprising a hollow casing having an inlet for receiving the contaminated stream of gas, a generator member axially supported within the casing and a plurality of vanes circumferentially arranged around the generator member for imposing a tangential velocity vector to the contaminant particles passing through the vanes, the generator member being formed in relation to the casing for rapidly decelerating the stream of gas and for imposing a radial velocity vector to the contaminant particles upon impact with the generator member such that the heavier contaminant particles are directed toward the inside wall of the casing prior to the stream passing through the vanes, and for further imposing a radial velocity vector to the lighter contaminant particles to direct said lighter contaminant particles toward the inside wall of the casing and for rapidly contracting the stream of gas subsequent to the stream of gas passing through the vanes, and the casing including a first passageway for carrying relatively clean gas external to the casing and a second passageway for carrying the deflected contaminants external to the casing.

In the accompanying drawings:—

Figure 1 is a sectional side view showing the structural components of the invention and the geometric relationships therebetween.

Figure 2 is a right end view, relative to Figure 1, showing a deflector member and vanes arranged therewith in accordance with the invention.

Figure 3 is a sectional view taken along the lines 3-3 in Figure 2 and showing a predetermined angular relationship between the vanes and the axis of the deflector member.

With reference to Figure 1, the device of the invention includes a hollow casing member 2 which includes a tapered inlet section 4 having an inlet end 6 for receiving a relative high velocity, axially flowing stream of gas I. The casing 2 has an annular centrally disposed section 8 secured at 10 to

the section 6 and an annular cap or outlet section 12 secured at 14 to the central section 8.

5 The outlet section 12 includes an axially disposed passageway 16 through which relatively clean gas G flows external to the device and further includes a passageway 18 disposed normal to the passageway 16 and communicating with a wall 12A of the outlet section 12 through which contaminant particles C flow external to the device in a manner and for reasons to be hereinafter explained. Passageway 18 includes a choke nozzle (not shown) which may be in screw threaded engagement therewith at 20 for flow control as is well known in the art.

A generator member 22 is axially disposed within the inlet section 4 and the portion of the central section 8 adjacent the inlet section 4. The generator member 22 includes a conoidal body 24 which tapers from one diameter at its forward end 26 to another larger diameter at its rearward end 28 to substantially follow the taper of the inlet section 4. The rearward end of the generator member 22 terminates in a cone 30.

In order to provide desired contamination particle separation characteristics as heretofore noted, the taper of the body 24 and the apex angle of the cone 30, as related to the inlet and central portions 4 and 8, respectively, of the casing 2, have been found to be significant. Thus, the portion of the body 24 within the conoidal inlet section 4 and wall 4A thereof taper at an angle A which may be, for purposes of illustration, 10°, while the portion of the body within the annular central section 8 tapers at a relatively steeper angle B which may be, for purposes of illustration, 15°. Likewise, the apex angle E of the cone 30 may be, for purposes of illustration, 100°. The purposes for the aforementioned angular relationships will hereinafter become evident.

With reference now to Figure 2, there is shown an annular rim 32 and a plurality of vanes 34, shown in the Figure as sixteen in number, arranged therewith and equidistantly disposed circumferentially around the body 24 adjacent the rearward end 28 thereof as shown in Figure 1. As shown in Figure 3, the vanes 34 are disposed at an angle D relative to the axis of the rim 32 and the body 24 and which angle D may be, for purposes of illustration, 30°, for reasons to be hereinafter explained.

The rim 32 including the vanes 34 is carried on the body 24 of the generator member 22 adjacent the rearward end 28 thereof as noted. The arrangement is such that the rim 32 is secured in a groove 36 formed in the adjacent ends of the inlet casing section 4 and the central casing section 8. To this extent, the generator member 22,

rim 32 and vanes 34 may be a unitary casting or a machined component, or may be separate components secured each to the other as will be understood by those skilled in the art. Likewise, although the inlet casing section 4, central casing section 8 and outlet casing section 12 have been illustrated as separate components, the casing 2 may be a single casting or a machined component or several components as may best be suited for manufacturing purposes, the same not being a significant feature of the invention being described.

It will be further understood that the described components of the invention may be constructed from any suitable metallic or non-metallic material and, which material is dependent upon the medium for which the device is intended, i.e. whether the gas involved is corrosive or non-corrosive as well as the temperature and pressure involved.

In operation, a relatively high velocity stream of contaminated gas I enters the casing 2 through the inlet section 4 as indicated by the arrow in Figure 1. The taper angle of the wall 4A and body 24, i.e. the heretofore noted angle A, causes rapid deceleration of the incoming gas and this causes the heavier contaminant particles to impinge upon the body 24 and, as a result of the momentum of these heavier particles, the impingement redirects the particles towards the wall 4A of the inlet section. Further, the lighter particles may impinge with either the body 24 or other redirected heavier particles in order to also, as a result of their momentum, be redirected towards the wall 4A. The impingement of these particles with the body 24 will result in the particles acquiring a radial velocity component which is normal to their original axial inlet velocity upon entering the separator device.

As the incoming gas passes from the inlet section 4 to the central section 8 of the casing 2, it passes through the vanes 34. The contaminant particles are impacted upon the blades and, as a result, the radial velocity component is magnified due to the configuration of the blades and their relationship to the flow of gas through the separators. Further, a tangential velocity component is imparted to the particle flow thereby causing the contaminant particles to further localise themselves against the inner wall 8A of the central section 8. The tangential velocity component causes the contaminant particles to adopt a slight swirl or circular motion, the degree of swirl depending upon the angle D (Fig. 3). The rearward end 28 of the body 24, within the central section 8, is at a relatively steeper angle than that section of the body within the inlet section 4, i.e. angle B, and at this point further separation is experienced

since the lighter contaminant particles which impinge upon the rearward end 28 of the body 24 acquire a radial velocity component to their axial velocity so that these lighter particles travel towards the inner wall 8A of the central section 8 to cause further separation of the contaminant particles of the flow of gas.

The angle E of the cone 30 is optimised so that the gas stream rapidly contracts without inducing flow separation.

With the contaminant particles directed towards the wall 8A and the gas stream contracted through the geometrical effect of the cone 30, relatively clean gas G is directed to the passageway 16 and exits therethrough as shown in Figure 1. The contaminant particles C now near the wall 8A exit through the passageway 18 as shown by the arrow in Figure 1, choked by the nozzle (not shown).

It will now be seen from the foregoing description of the invention that the separation of contaminant particles from the incoming stream of gas is achieved with high efficiency and a low pressure drop by optimizing the geometrical relationships of the components of the invention. Thus, of significant importance are the taper angles A and B of the body 24 of the generator member 22. Similarly, the angle E of the cone 30 is significant for providing a rapid contraction of the air stream and directing the clean air through the passageway 16 as noted. Likewise, the vane angle D, shown in Figure 3, is optimized to provide the proper tangential velocity component to the contaminant particles so as to eliminate the effect of prior art devices wherein centrifugal force has been generated and has caused undesirable abrasive effect.

#### WHAT WE CLAIM IS:—

1. A device for separating solid contaminants from a relatively high velocity axially flowing stream of gas comprising a hollow casing having an inlet for receiving the contaminated stream of gas, a generator member axially supported within the casing and a plurality of vanes circumferentially arranged around the generator member for imposing a tangential velocity vector to the contaminant particles passing through the vanes, the generator member being formed in relation to the casing for rapidly decelerating the stream of gas and for imposing a radial velocity vector to the contaminant particles upon impact with the generator member such that the heavier contaminant particles are directed toward the inside wall of the casing prior to the stream passing through the vanes, and for further imposing a radial velocity vector to the lighter contaminant particles to direct said lighter contaminant particles toward the

inside wall of the casing and for rapidly contracting the stream of gas subsequent to the stream of gas passing through the vanes, and the casing including a first passageway for carrying relatively clean gas external to the casing and a second passageway for carrying the deflected contaminants external to the casing.

2. A device for separating solid contaminants from a relatively high velocity axially flowing stream of gas comprising a hollow casing for receiving the stream of gas at one end and for discharging relatively clean gas and the separated contaminants at the other end, a generator member axially supported within the casing and having first and second sections, the first section being formed in relation to the casing for rapidly decelerating the incoming stream of gas with the impact of the stream of gas on the first section imposing a radial velocity vector to the contaminant particles such that the contaminant particles are directed toward the wall of the casing, a plurality of vanes circumferentially arranged around the generator member ahead of the second section thereof and angularly disposed relative to the axis of the generator member for imposing a tangential velocity vector to the contaminant particles in the stream of gas, the second section being formed in relation to the casing for further imposing a radial velocity to said contaminant particles and for rapidly contracting the stream of gas, the opposite end of the casing including an axial externally extending passageway through which the relatively clean gas is discharged and a further passageway extending normal to said first-mentioned passageway and communicating with the wall of the casing and through which the contaminants are discharged.

3. A device for separating solid contaminants from a relatively high velocity axially flowing stream of gas comprising a hollow casing having a tapered inlet section for receiving the axially flowing stream of gas, an annular central section affixed at one end to the inlet section and an annular outlet section affixed to the opposite end of the central section; a generator member axially supported within the hollow casing and having a forward portion within the inlet section and a rearward portion within the central section, the forward portion being tapered to follow the taper of the inlet section, said taper being in an increasing sense at a predetermined angle for rapidly decelerating the stream of gas, with the heavier contaminant particles being directed toward the wall of the casing upon impinging with the forward portion of the generator member and thereby acquiring a radial velocity vector, a plurality of vanes circumferentially disposed around the

- generator member ahead of the rearward portion thereof, said vanes being disposed at a predetermined angle relative to the axis of said generator member for imposing a tangential velocity vector to the contaminant particles in the stream of gas; the rearward portion of the generator member being tapered in an increasing sense at a predetermined steeper angle than the forward portion such that the lighter contaminant particles impinge upon the rearward portion and acquire a radial velocity vector which directs said lighter particles to the wall of the casing, the rearward portion of the generator member terminating in a cone having a predetermined apex angle for rapidly contracting said stream of gas without causing flow separation between said relatively clean gas and said contaminant particles; and the outlet section having an axial externally extending passageway through which relatively clean gas is discharged and a further passageway extending normal to said first-mentioned passageway and communicating with the wall of the casing through which the contaminants are discharged.
4. A device for separating solid contaminants from a relatively high velocity axially flowing stream of gas, substantially as herein described with reference to and as shown in the accompanying drawing.
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1 SHEET

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